mixtures of soy-bean oil up to 50 per cent with tung or linseed oils.

3—Domestic soy-bean oil is practically identical chemically and physically with the imported oils. Excellent soy-bean oil has been produced in this country, the whole Southern section of which is admirably suited to the growth of the beans.

4—Samples of soy-bean oil from different varieties of beans, subjected to different methods of extraction, length of storage, soil conditions, and maturity of the seed when harvested, vary considerably in their physical and chemical properties.

5—The average amount of oil obtained from twenty-six different varieties of soy-beans was 18.3 per cent; Ebony was lowest with only 14.8 per cent, while O'Kute was highest with 25.6 per cent. Such vast differences between varieties is of very great importance in growing soy beans for the oil market.

6—The length of growing season influences the oil content of soy-bean seeds. The oil content becomes less as the date of planting is later in the season. The number of days required to reach maturity is materially shortened when plantings are made during the middle and late summer. For growing soy beans as a catch crop or second crop on the same land, this fact is of prime importance.

7—There is considerable variation in the color and drying power of soy-bean oils derived from different varieties of soy beans.

The Alkalinity of Searles Lake Brine[1,2]

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The article by J. E. Teeple[3] on the operations of the American Trona Corporation at Searles Lake approaches the ideal, in the opinion of the writer, in divulging to the public the methods and accomplishments of a large company that has carried on considerable chemical research, while at the same time specifying the particular points that have been made the subject of patent applications. The writer visited the plant of this company at Searles Lake in the fall of 1920 and was given an opportunity to inspect the equipment and methods of operation that Mr. Teeple describes. It is a great pleasure to express appreciation of the courtesies shown at that time.

The Searles Lake brine is a very interesting subject for investigation from a geochemical point of view as well as for its commercial value. Although it is recent, geologically speaking, it is changing so slowly, if at all, at the present time that the changes probably cannot be detected. It is possible, however, to determine the salts that separate on evaporation at various temperatures and the relation of certain physical properties of the brine to its components. The actual alkalinity of the brine, as measured by the H-ion concentration, is a property to which the writer has given some attention, with special reference to its use in arriving at a logical form of expression of the analysis of the brine. Very little has been published on the problem of determining carbonate and bicarbonate in the presence of borax and metaborate.

ANALYSIS OF BRINE

The sample of brine on which the experiments described below were made was collected from Well 86, at a depth of 35 to 40 ft., Sept. 20, 1913, by W. B. Hicks, of the United States Geological Survey. It had stood in a quart glass bottle without being opened until the present determinations were made. The H-ion concentration was then found to be 3.32×1^{-10} at 25° C., or, as usually expressed pH = 9.48. The apparatus used in making this determination has been previously described.[1] The tabulated determinations were also made using the usual methods, such as are described in *Bulletin* 700 of the United States Geological Survey.

DETERMINATIONS, SEARLES LAKE BRINE

	Per cent of Brine
K	2.46
Cl	12.32
SO_4	4.72
CO_2	1.84
B_2O_3	1.04
Specific gravity at 25°	1.204

1 cc. requires 13.1 cc. 0.1 *N* HCl with methyl orange.
1 cc. requires 12.85 cc. 0.1 *N* HCl with *p*-nitrophenol.
1 cc. requires 3.80 cc. 0.1 *N* NaOH to phenolphthalein end-point after removing CO_2 and making exactly neutral to *p*-nitrophenol.

CONVERSION OF ANALYTICAL RESULTS

The next problem is to convert the above determinations into the form of salts, which is the most logical form of expression for several reasons: First, the brine as it comes from the lake has been in contact with various salts, and similar salts can be obtained from it by evaporation. Second, after calculating the potassium to some one salt, such as potassium chloride, all the other salts may be expressed as sodium salts. Third, the actual pH alkalinity of the brine lies between the limits shown by solutions of sodium carbonate and sodium bicarbonate on the one hand and sodium tetraborate (borax) and sodium metaborate on the other. The special problem here is to convert the total CO_2 found into Na_2CO_3 and $NaHCO_3$ and the total B_2O_3 into $Na_2B_2O_4$ and $Na_2B_4O_7$. Titration methods are of no avail because there are four salts to be titrated and the titration curve gives no sharp breaks for the various salts. Modes of expression based on arbitrary assumptions lead to confusion unless the assumptions have some logical basis, and for this reason attempts to convert the CO_2 and B_2O_3 into only two or three salts are unsatisfactory, because the chemist realizes that any such that could be chosen would react on each other if dissolved, producing at least the four salts that have been mentioned. The writer has sought to overcome these difficulties by determining in separate experiments what proportions of the salts of each buffer pair, *i. e.*, the carbonates and the borates, would be required to give the same pH value as found for the brine. He has also shown that if the proportions found for one pair are taken to represent the concentrations of those two salts in the brine, the proportions for the other pair must be as determined. The results obtained appear to yield a form of expression that is free from the above objections.

ARTIFICIAL BRINE—An artificial brine containing only sodium chloride, potassium chloride, and sodium sulfate in the concentrations found in the Searles Lake brine was made up to serve as a medium to which buffer salts could be added in various amounts, thus making any possible "salt effect" constant and equal to that in the Searles brine. A set of pH determinations was made with this brine after adding various proportions of sodium carbonate and bicarbonate, keeping the total CO_2 equal to that found in the Searles brine. A similar set was made with mixtures of borax and sodium metaborate, keeping the total B_2O_3 the

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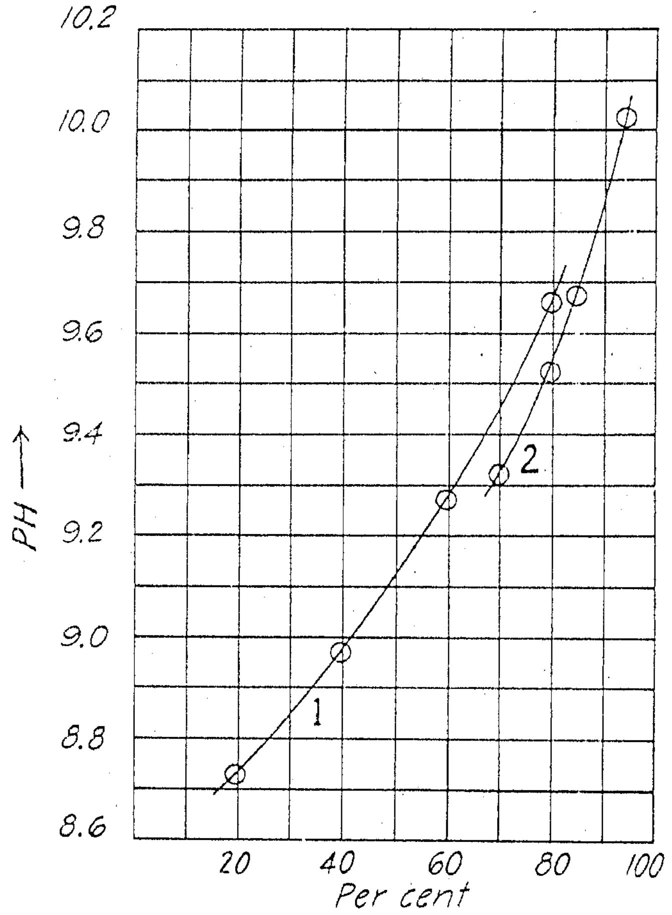
[1] Received April 1, 1921.

[2] Published by permission of the Director of the U. S. Geological Survey.

[3] THIS JOURNAL, **13** (1921), 219.

[1] *J. Am. Chem. Soc.*, **42** (1920), 2160.



pH FOR MIXTURES OF $Na_2B_4O_7$ AND $Na_2B_2O_4$, AND OF $NaHCO_3$ AND Na_2CO_3 IN SEARLES LAKE BRINE. CURVE 1—PER CENT OF TOTAL B_2O_3 PRESENT AS $Na_2B_2O_4$. CURVE 2—PER CENT OF TOTAL CO_2 PRESENT AS Na_2CO_3

same as found in the Searles brine. The metaborate was produced by the addition of the necessary quantity of a strong caustic soda solution to borax. In the experiments with the borate buffers they were added to a slightly more concentrated solution in order that the water of composition should yield the same final dilution as in the Searles brine. The results of H-ion determinations on these mixtures are given in Table I, and plotted in the accompanying figure.

TABLE I—RESULTS OF pH DETERMINATIONS MADE BY ADDING (*a*) CARBONATE AND (*b*) BORATE BUFFERS TO AN ARTIFICIAL BRINE RESEMBLING SEARLES LAKE BRINE

Percentage of Total CO_2 Present as Na_2CO_3	pH	Percentage of Total B_2O_3 Present as $Na_2B_2O_4$	pH
94	10.02	80	9.66
85	9.67	60	9.27
80	9.52	40	8.97
70	9.32	20	8.73

When the pH values are plotted against the percentages in each case, the results are found to give smooth curves, from which it is easily seen that in order to yield the value pH = 9.48 the total CO_2 and B_2O_3 should be distributed as follows in the respective salts:

$$CO_2 \left\{ \begin{array}{l} \text{78 per cent as } Na_2CO_3 \\ \\ \text{22 per cent as } NaHCO_3 \end{array} \right. \qquad B_2O_3 \left\{ \begin{array}{l} \text{71 per cent as } Na_2B_2O_4 \\ \\ \text{29 per cent as } Na_2B_4O_7 \end{array} \right.$$

or, as percentages of the brine:

$$Na_2CO_3 = 3.46 \qquad Na_2B_2O_4 = 1.39$$
$$NaHCO_3 = 0.77 \qquad Na_2B_4O_7 = 0.43$$

It seemed reasonable to suppose from the principles of equilibrium in salt solutions that two mixtures of buffer salts yielding the same pH value in separate equal portions of a given medium would show no change in pH when dissolved together in a single portion, but in order to strengthen this assurance all four salts were dissolved in the artificial brine in the proportions last mentioned and the solution tested. The pH value found was 9.50, which agrees well with the value 9.48, on which the proportions of the buffers were based, and proves that there is no reaction of the buffer salts on each other when they are taken in the proportions that give the same pH values separately.

In Table II is given the analysis of Searles Lake brine in the form deduced from the present study, together with Teeple's analysis and an earlier one based on determinations by W. B. Hicks,[1] for comparison.

TABLE II—ANALYSIS OF SEARLES LAKE BRINE

	Wells	Teeple	Hicks
KCl	4.69	4.82	4.00
NaCl	16.63	16.54	17.27
Na_2SO_4	6.98	7.16	6.48
Na_2CO_3	3.46	4.17	4.65
$NaHCO_3$	0.77	0.52	.....
$Na_2B_2O_4$	1.39	0.85	.....
$Na_2B_4O_7$	0.43	0.85	1.42
H_2O	65.65	65.09	66.18
TOTAL	100.00	100.00	100.00

Another interesting characteristic of the brine from the geochemical point of view is its carbon dioxide tension. Will the brine gain or give off carbon dioxide on exposure to the atmosphere? To answer this question 100 cc. of the brine were agitated in a thermostat at 23° C. by means of a vigorous current of filtered and washed outdoor air for 111 hrs. During the first 15 hrs. the total carbon dioxide content remained practically unchanged when referred to the same volume; but meanwhile the brine was very slightly diluted, so that the proportion of carbon dioxide in the total salts increased slightly. On further treatment the proportion of carbon dioxide in the total salts appeared to remain nearly constant, as shown in Table III.

TABLE III—TOTAL CO_2 IN SEARLES BRINE BEFORE AND AFTER AGITATION WITH OUTDOOR AIR

Time of Agitation Hours	CO_2 per Liter Grams	Specific Gravity of Brine	Estimated Total Salts per Liter	Percentage of CO_2 in Total Salts
0	23.78	1.294	451.9	5.26
15	23.80	1.289	443.0	5.37
63	23.06	1.283	433.1	5.32
111	22.59	1.274	418.1	5.40

As the slight increase in CO_2 in the total salts may be due to the increased dilution and accompanying hydrolysis, it seems fairly safe to conclude from the above results that the brine is very nearly in equilibrium with the atmosphere so far as its content of carbon dioxide is concerned.

Fertilizer Imports

During the ten-month periods ending in April 1921 and April 1920, imports of fertilizers (in long tons) in the United States were as follows:

	1920	1921
Ammonium sulfate	2,117	2,011
Bone dust, ash meal	5,354	26,237
Calcium cyanamide	72,510	33,516
Guano	14,045	37,519
Kainite	202,430	202,076
Manure salts	217,064	123,168
Potassium salts:		
Muriate	99,843	48,442
Sulfate	5,344	11,368
All other fertilizers	93,378	108,327
TOTALS	712,085	592,664
Sodium nitrate (not included in above table)	605,436	768,121

The War Department is to distribute more than 12,000,000 lbs. of picric acid to farmers for agricultural purposes. This surplus stock accumulated for war purposes, is located at Sparta, Wis., and Wingate, N. M., and will be distributed through the Bureau of Public Roads of the Department of Agriculture, the only cost to farmers being freight charges and six cents a pound for placing the powder in the necessary cartridges.

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[1] United States Geological Survey, "Mineral Resources," 1917, II, 411.